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AN EXPLANATION OF THE MAGNETIC ATLAS, OR VARIATION CHART,

HEREUNTO ANNEXED;

PROJECTED ON A PLAN

ENTIRELY NEW.

BY WHICH THE MAGNETIC VARIATION ON ANY PART OF THE GLOBE MAY BE PRECISELY DETERMINED, FOR ANY TIME, PAST, PRESENT, OR FUTURE: AND THE VARIATION AND LATITUDE BEING ACCURATELY KNOWN, THE LONGITUDE IS OF CONSEQUENCE TRULY DETERMINED.

BY JOHN CHURCHMAN,

Late land ſurveyor for the diſtrict of the counties of Delaware *and* Chester,
and for part of Lancaster *and* Berks, Pennsylvania.

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M, DCC, XC.

Diſtrict of Pennſylvania, to wit.

BE it remembered, that on the ſeventeenth day of June, in the fourteenth year of the Independence of the United States of America, *John Churchman*, of the ſaid diſtrict, hath depoſited in this office, the title of a book, and the title or dedication of a chart, the right whereof he claims as Author, the title of the book being in the words following, *to wit.*

"*An Explanation of the Magnetic Atlas, or Variation Chart, hereunto annexed*; projected on a plan entirely new, by which the *Magnetic Variation* on any part of the globe may be preciſely determined, for any time, paſt, preſent, or future: and the variation and latitude being accurately known, the *longitude* is of conſequence truly determined: By *John Churchman*, late land-ſurveyor for the diſtrict of the counties of Delaware and Cheſter, and for part of Lancaſter and Berks, Pennſylvania;" and the title or dedication of the chart being in the words following, *to wit:*"

"To *George Waſhington*, Preſident of the United States of *America*, this *Magnetic Atlas*, or *Variation Chart*, is humbly inſcribed by *John Churchman*:"—in conformity to the Act of the Congreſs of the United States, entitled, "An act for the encouragement of learning, by ſecuring the copies of maps, charts, and books, to the authors and proprietors of ſuch copies, during the terms therein mentioned."

SAMUEL CALDWELL,
Clerk of the Diſtrict of
PENNSYLVANIA.

PREFACE.

IT appears probable that one of the principal cauſes, why more uſeful diſcoveries are not made, is the fear of ridicule, which is ſometimes the fate of projectors who promulgate new opinions, and attempt new experiments. A deſire of avoiding the ſarcaſms of ignorance and malevolence, may ſuppreſs many uſeful inventions; yet we find ſome gradually preſs forward; and although, for want of encouragement, an hundred probable ſchemes may ſink in oblivion, there will ever be ſome of ſuch magnitude, in the eyes of their own inventors, that, regardleſs of the "*world's dread laugh,*" they will burſt into day, and either go off in vapour, or remain permanent lights.

In a ſituation of ſpeculative enquiry, I confeſs I had long continued; and in the beginning of the year 1787, I riſked a declaration of my opinions before the public, apprehending I had formed a plan of much importance to navigation, confiding in their generoſity to give it a candid reception, which in a great meaſure I was ſo fortunate as to obtain: and as the firſt principles ſeem at preſent to be univerſally admitted, I have the more reaſon to hope for further indulgence towards this little tract, which is deſigned to accompany and explain the Magnetic Atlas, or Variation Chart of all the Northern Hemiſphere. If any imperfections ſhould be found in either of them, the reader is reſpectfully ſolicited to ſupply the defect; and I truſt, notwithſtanding, under a conviction that they will do no *injury* to mankind, they may at leaſt obtain for me their pardon, if not their thanks for my *intention* of rendering them a *ſervice*. And yet, I muſt acknowledge, that, in purſuing this ſubject, I conſidered it alſo as an object of emolument, although in this reſpect I have done nothing more, than to accept the invitation held out by many Governments, with promiſes of a generous reward, to engage perſons in the public ſervice.

Having premiſed thus much, I ſhall, in the following treatiſe, proceed to deſcribe, in a more particular manner, the elements of a ſyſtem, which, I apprehend, attains to the actual and complete *Diſcovery of the* Longitude.

This indeed is a ſubject which, hitherto, has generally excited a ſmile, whenever attempted; yet I have riſked *that*, for the public good.

The variation of the compaſs, and its heretofore (imagined) uncertain laws, have long engaged the attention of philoſophers. Why it ſhould change, and become at one time *ſlow*, at another time *quick*, now *ſtationary*, and then *retrograde*, has puzzled the enquirer. Theſe have long been ſubjects of obſervation; yet I have never heard that any regular ſyſtem has hitherto been publiſhed, to account for or foretell, upon any rational plan, what will be the future movements of this wonderful phenomenon, the magnetic influence. Whether my attempts to reconcile all theſe difficulties, and, of conſequence, to build on them a certain ſyſtem of longitude, will prove ſucceſsful, or not, muſt be left to the world to judge.

The propoſed problems may be ſolved by the magnetic atlas alone, without an accurate knowledge of the magnetic elements; but as the elements reſult from a multitude of obſervations, reflections, and deductions, and are the leading principles on which the chart is conſtructed, perhaps an explanation of them may not be unacceptable. They will appear in the firſt chapter, and will, no doubt, be found eaſy and intelligible, but more eſpecially to all thoſe who have in the leaſt degree applied themſelves to the ſtudy of ſpherical geometry, or the uſe of the globes.

As the introduction of a number of new terms appeared abſolutely neceſſary, the liberty taken in this reſpect will be deemed pardonable.

Subſcribers Names come to hand.

TITLES are conſidered as being of ſeveral kinds: 1ſt, Such as are merely epithetical; 2d, the uſual names of office; 3d, appendages, &c. In a republican government, it is hoped that none in the following liſt will be offended at the omiſſion of the former, eſpecially as the perſonage to whom the Magnetic Atlas is addreſſed has generally no other title than that of Preſident of the United States. Were there a conformity to cuſtom, thoſe diſtinguiſhed characters would have the correſponding epithets prefixed, ‡ Right Reverend, † Reverend, § His Excellency, * Honourable: thoſe marked ‖ are members of the American Philoſophical Society.

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AN
EXPLANATION
OF THE
MAGNETIC ATLAS,
OR
VARIATION CHART, &c.

CHAP. I.

Elements of Magnetiſm.

Propoſition I. F*ROM a multitude of obſervations on the Magnetic Variation, in different parts of the world or places whoſe ſituations have been well determined, it is found that the magnetic horizontal needle hath an univerſal direction towards two points on the ſurface of the globe, t certain diſtances, one from the north, the other from the ſouth Pole of the earth.*

Definition I. One of the points towards which he magnetic needle hath a direction, being n the northern hemiſphere (for diſtinction) may be called the *northern magnetic point.*

Def. II. As the other magnetic point is at certain diſtance from the ſouth pole of the earth, it may be termed the *ſouthern magnetic point*.

Note. The northern magnetic point on the chart is diſtinguiſhed by Z.

Prop. II. *The northern magnetic point, in the beginning of the year* 1777, *was in about the latitude of* 76° 4′ *north, and longitude* 90° 58′ *weſt, from Greenwich.*

Prop. III. *The ſituation of the ſouthern magnetic point, in the year* 1777, *I calculated to have been in even numbers in* 72° *ſouth latitude, and* 140° *eaſt longitude from Greenwich.*

Poſtulate. As on a plain a circle can be drawn through any three points, not in a direct line; ſo, on the ſurface of a globe, a circle or curve may be drawn through any three points whatever.

Prop. IV. *A circle drawn through three points on the ſurface of a globe, if the plane of the ſaid circle paſſes through the centre of the globe, will be a great circle.*

Prop. V. *If through three points on the ſur-face of a globe a circle be drawn, whoſe plane paſſe not through the centre of the earth; it will be a leſſe circle.*

Def. III. A magnetic meridian is a curve drawn from one magnetic point to the other, through any given part of the globe.

Def. IV. A meridian of the earth is here underſtood to be a ſemicircle, although this term is alſo ſometimes applied to a great circle

Def. V. The angle between a meridian of the earth, and the magnetic meridian, is the variation of the compaſs.

Prop. VI. *Although the length of the mean time taken by the ſun from its departure from, until its return again to any one meridian of the earth, is well known to be juſt twenty-four hours, yet the mean time of the rotation of the earth on its axis from weſt to eaſt is determined and known to be* $23^{h}\ 56^{\prime}\ 4^{\prime\prime}$.

Prop. VII. *The two magnetic points have a perpetual motion, and alſo perform revolutions round the two poles of the earth, from weſt to eaſt, as pointed out in the tables of their different ſituations; the northern one quicker, and the ſouthern ſlower than the earth.*

Def. VI. The time in which either magnetic point revolves round the pole of the earth, from a conjunction with any fixed ſtar, until its return to the ſame again, may be termed its *ſideral revolution*.

Def. VII. The time which either magnetic point requires from its leaving any one meridian of the earth, until its return to the ſame again, may be termed its *periodical revolution*.

Prop. VIII. *The ſideral revolution of the northern magnetic point is* $23^{h}\ 55^{\prime}\ 55^{\prime\prime}\ 48^{\prime\prime\prime}\ 50^{\prime\prime\prime\prime}$, *and its periodical revolution* $426^{y}\ 77^{d}\ 9^{h}$.

Prop. IX. *The ſideral revolution of the ſouthern magnetic point is* $23^{h}\ 56^{\prime}\ 4^{\prime\prime}\ 38^{\prime\prime\prime}$, *and its periodical revolution* 5459 *years, or thereabouts.*

Prop. X. *The two magnetic points are ſometimes on the ſame meridian of the earth; ſometimes on oppoſite meridians, and ſometimes on neither.*

Prop. XI. *Whenever the two magnetic points are either on the ſame or on oppoſite meridians of the earth, then thoſe meridians and the line of no-variation coincide with each other.*

Note. By the tables we find that in the year 1832 the ſouthern magnetic point will be 136° 22′ eaſt from Greenwich, and in the year 1833 the northern magnetic point will be 43° 40′ weſt from the ſame meridian, the ſum of theſe numbers is 180° 2′. Therefore, as any two oppoſite meridians are always 180° aſunder, the two magnetic points about this time will be on oppoſite meridians. Then will the line of no variation be a meridian of the earth, when the calculation will be much more ſimple

Def. VIII. The line of no-variation is a line drawn through the different parts of the globe where the magnetic needle points due north.

Note. The line of no-variation is diſtinguiſhed on the magnetic atlas by a broken curve line, one part of which is now to the weſtward of Philadelphia.

Prop. XII. *The line of no-variation changes its place, as the two magnetic points change their places.*

Prop. XIII. *The line of no-variation alters its curvature, in proportion to the different poſitions of the two magnetic points.*

Prop. XIV. *Whenever the two magnetic points are neither on the ſame nor on oppoſite meridians of the earth, then thoſe parts, where ſome of the magnetic meridians coincide with other parts of different meridians of the earth, will be the line of no-variation.*

Axiom. If the two magnetic points were at equal diſtances from the two poles of the earth, and on oppoſite meridians, they would be diametrically oppoſite to each other.

Prop. XV. *If the two magnetic points were diametrically oppoſite to each other, all the magnetic meridians would be ſemi-circles.*

Prop. XVI. *As the two magnetic points are neither at equal diſtances from the two poles of the earth, nor at preſent on oppoſite meridians, they are not diametrically oppoſite to each other: And,*

Prop. XVII. *As the two magnetic points are not diametrically oppoſite to each other, none of the magnetic meridians, except two, are arches of great circles.*

Def. IX. A circle drawn every way equally diſtant from and between the two magnetic poles, magnetic points, or magnetic nadirs, will be the *magnetic equator*.

Note. The magnetic equator is diſtinguiſhed in the chart by a line paſſing through the Indian Ocean, between the Iſlands of Ceylon and Sumatria.

Def. X. A point diametrically oppoſite the ſouthern magnetic point, may be termed the *northern magnetic nadir*.

Note. The northern magnetic nadir on the chart is diſtinguiſhed by the letter W.

Def. XI. A point diametrically oppoſite the northern magnetic point, may be termed the *ſouthern magnetic nadir*.

Prop. XVIII. *Although the plane of the only two magnetic meridians, which are arches of great circles, is continually changing, yet the magnetic points, the magnetic poles, and magnetic nadirs, are always in the plane of the ſame.*

Prop. XIX. *The magnetic equator divides the globe into two equal parts.*

Axiom. I. Every circle dividing the globe into two equal parts, is a great circle.

Axiom II. Every great circle has two poles.

Axiom III. The two poles of every great circle are diametrically oppoſite to each other.

Corollary. *Hence the two magnetic poles bein diſtinct from the two magnetic points, which influenc the direction of the needle, are nothing more than th poles of the magnetic equator.*

Note. The northern magnetic pole is diſtinguiſhed in the chart by the letter X.

Def. XII. A right line drawn from one magnetic point to the other, may be called the *magneti pointer-axis*.

Def. XIII. A right line drawn from one magnetic pole to the other, may be termed the *magnetic polar-axis*.

Def. XIV. A right line drawn from one magnetic nadir to the other, may be called the *magnetic nadir-axis*.

Prop. XX. *The magnetic polar-axis, and no other, paſſes through the center of the earth.*

Prop. XXI. *The magnetic polar-axis is equally diſtant from and between the magnetic pointer-axis and magnetic nadir-axis, all of which are parallel to each other.*

Prop. XXII. *As the two magnetic points are not diametrically oppoſite to each other, the diſtance between the magnetic points and the magnetic equator, is different on different ſides of the globe; but,*

Prop. XXIII. *The diſtance between the magnetic poles and the magnetic equator is always equal on every ſide of the globe.*

Prop. XXIV. *As the two magnetic points move with unequal velocities, the diſtance between the magnetic pole and the magnetic point undergoes a continual alteration.*

Prop. XXV. *As the diſtance between the magnetic points and the magnetic poles increaſe, ſo all the magnetic meridians which are not arches of great circles decreaſe.*

Def. XV. As the magnetic equator divides the globe into two equal parts, for diſtinction, one half may be called the *northern*, and the other the *ſouthern magnetic hemiſphere.*

Prop. XXVI. *In each magnetic hemiſphere, the magnetic pole is at any given time equally diſtant from the magnetic point and the magnetic nadir.*

Def. XVI. Thoſe two points at the interſection of the magnetic equator, and the equator of the earth, may be termed the *magnetic equinoctial points.*

Prop. XXVII. *The two magnetic equinoctial points are diametrically oppoſite to each other.*

Prop. XXVIII. *The diſtance between the magnetic pole and the pole of the earth, in either hemiſphere, is equal to the angle at either magnetic equinoctial point formed by the magnetic equator and the equator of the earth.*

Prop. XXIX. *Whenever the line of no-variation is the ſame with a meridian of the earth, if biſected by the magnetic pointer-axis, it alſo repreſents the only two magnetic meridians, which are arches of great circles.*

Def. XVII. The dipping-needle is a magnetic needle ſuſpended on a pin, paſſing through its centre in a horizontal direction.

Axiom. Magnetic powers of equal force have equal influence, at equal diſtances.

Corol. I. *As the magnetic equator is equally diſtant from each magnetic point, if the dipping-needle* *ſtood horizontal on the magnetic equator, the influence of each magnetic point would be equal.*

Corol. II. *If the influence of each magnetic point were equal, the magnetic meridians would be all circular curves.*

Corol. III. *If the magnetic meridians were all circular curves, they might be conſidered as parts of regular polygons of an infinite number of ſides, and the horizontal magnetic needle would always repreſent one of thoſe ſides.*

Corol. IV. *If thoſe magnetic meridians which are not arches of great circles, be circular curves or not, the horizontal magnetic needle will make always a tangent to the magnetic meridian.*

Prop. XXX. *In the northern magnetic hemiſphere the dipping-needle gives the north dip, and in the ſouthern the ſouth dip, proportionally to the diſtance from the place where it ſtands horizontal.*

Prop. XXXI. *The magnetic equator, as well as thoſe two magnetic meridians, which are arches of great circles, continually changes its place.*

Def. XVIII. If on a globe a number of circles be drawn parallel to the magnetic equator, they may be termed parallels of *magnetic Latitude*.

Prop. XXXII. *If any one magnetic meridian be calculated as a great circle, which is not ſuch, the difference of the angle of magnetic variation between the calculation and actual obſervation will be proportioned to the magnetic latitude.*

Prop. XXXIII. *If, in the ſame parallel of magnetic latitude, any number of magnetic meridians be calculated as great circles, which are not ſuch, the difference of magnetic variation between the calculation and obſervation will be proportioned to the number of degrees on the magnetic equator, computed from its interſection with one of the two magnetic meridians, which are arches of great circles.*

Def. XIX. Spherical Trigonometry is that ſcience which teaches how to calculate the parts of triangles formed on the ſurface of a ſphere, by three arches of great circles.

Note. The leſſer circles of the ſphere, by different authors on this ſubject, have heretofore been declared not to fall under trigonometrical calculation, not only becauſe they are of different magnitudes, or that they have not the ſame radius as the great circles; but alſo, becauſe their planes do not neceſſarily cut one and the ſame axis, nor paſs through the centre of the ſphere.

Corol. *Hence as, by the preſent method, leſſer circles of the ſphere are calculated, as well as great circles, a new branch of ſcience is obtained.*

CHAP. II.

Solution of ſeveral Problems.

PROBLEM I.

Given, the ſituation of the place.

Required, the variation of the compaſs for any time paſt, preſent, or future.

FIND firſt the place of both the magnetic points, by the tables; ſecondly, draw a curve from one magnetic point to the other, through the given place; this curve will be the magnetic meridian, and the contained angle between the magnetic meridian, thus drawn, and the meridian of the earth at the given place, is the variation of the compaſs for that time.

EXAMPLE.

For the time to which the chart is fitted, it is required to know the variation of the compaſs in latitude 44° 30′ north, and longitude 170° eaſt from Greenwich.

Firſt find where this meridian and parallel of latitude meet on the chart, then trace thoſe two meridians ſlightly with a pencil, from the interſection, the length of the radius of the circle from which the line of chords is conſtructed, that they may be better diſtinguiſhed.

Secondly, meaſure the angle between the meridian of the earth and the magnetic meridian, or between the black line and dotted line, which is the ſame thing, which angle is 20 degrees: and as the dotted line runs here to the eaſtward of the black line, the variation is conſequently 20 degrees eaſt.

Note. Efface with a rubber the mark made by the pencil, that the chart may not be injured.

PROLLEM II.

Given, the variation of the compaſs, and latitude.

Required, the longitude.

Find what is the angle of variation at the interſection of the deſired meridian and parallel of latitude, and when the obſervation of the variation is equal to the variation on the chart, the ſhip muſt be in the longitude required.

EXAMPLE I.

A ſhip ſailing in the latitude of 50° north, on a voyage from Philadelphia to London, it is required to know when ſhe is within twenty degrees of the meridian of Greenwich. In meaſuring the angle on the chart between the twentieth meridian from Greenwich and the magnetic meridian, in the latitude of 50° north, it is found to be 22° 20′ weſt: ſo that when the accurate obſerver finds 22° 20′ weſt variation in the latitude of 50° north, he knows himſelf to be 20° weſt from the meridian of Greenwich.

EXAMPLE II.

A ſhip is bound from Philadelphia to Liſbon, and is ſailing in the latitude of 40° north; it is required to know when ſhe is within 15 degrees of the meridian of Greenwich: the angle between the black and dotted lines is meaſured at the interſection of the fortieth degree of latitude, and the fifteenth meridian from Greenwich; this angle is found to be 19° 10′; therefore, when the variation is 19° 10′ weſt in the latitude of 40° north, the obſerver muſt conſequently be within fifteen degrees of the meridian of Greenwich; and as Liſbon is 8° 52′ weſt from Greenwich, if this is ſubtracted from 15°, it gives 6° 8′ for the longitude of the place of obſervation weſt from Liſbon. 9

PROBLEM III.

To find the ſituation of thoſe two magnetic meridians, which alone are arches of great circles for any given time:

Find firſt the place of the magnetic points by the tables, for the time required; ſecondly, find either of the two magnetic nadirs which are oppoſite to the two magnetic points; thirdly, draw a circle through theſe three points, and this will always be a great circle: fourthly, biſect this great circle with the magnetic axis, which is a right line paſſing from one magnetic point to the other, and theſe two parts will repreſent thoſe only two magnetic meridians which are arches of great circles for any given time.

EXAMPLE.

For the beginning of the year 1794 (the time for which the chart is conſtructed) we find, by the tables, that the northern magnetic point will be 76° 37′ 17″ weſt from Greenwich, and that in the year 1792 the ſouthern magnetic point will be 139° eaſt from the ſame meridian: as the ſouthern magnetic point alters its place by ſlow degrees, two years will make but a ſmall difference. Then ſeeing it is ſelf-evident that two oppoſite meridians are always 180° apart, becauſe 139° added to 41° are equal to 180°, the northern magnetic nadir muſt be 41° weſt from Greenwich, and the ſame diſtance from the equator as the ſouthern magnetic point; therefore, a circle drawn through the northern magnetic point Z, the northern magnetic nadir W, and the ſouthern magnetic point, will be a great circle; and if this circle is biſected by the magnetic axis, theſe two parts will be the only two magnetic meridians which are to be arches of great circles for that time.

PROBLEM IV.

To find the ſituation of the magnetic equator for any given time:

Find firſt the ſituation of thoſe two magnetic meridians which are arches of great circles for the time required, by the laſt problem; ſecondly, find a point in one of thoſe magnetic meridians which are arches of great circles, half way between the magnetic point and magnetic nadir; this will be the magnetic pole: thirdly, draw a circle every way 90° diſtant from the magnetic pole, which will be a great circle, and will be the magnetic equator.

EXAMPLE.

The northern magnetic pole is diſtinguiſhed on the chart by the letter X; and if a great circle is drawn every way 90° diſtant from X, it will paſs between the iſlands of Ceylon and Sumatra, and will be the magnetic equator for that time, as will appear by the name thereof on the chart.

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CHAP. III.

The Objection of falſe Variation removed.

IF occaſion ſhould require, it will be very eaſy to compare the Magnetic Atlas with Captain Cooke's obſervations; and although the agreement may not be exact, this will be accounted for, from ſeveral cauſes: Firſt, the variation of the compaſs at the ſame place being ſubject to change, the length of time between Cooke's laſt obſervations, and the time for which the Magnetic Atlas is conſtructed, will cauſe a conſiderable difference: Secondly, notwithſtanding Captain Cooke, and the officers who bore him company, were poſſeſſed of very great abilities in the line of their profeſſion,—perhaps, neither the variation of the needle, nor the ſituation of the place where it was obſerved, was at all times truly determined. The principal cauſe of falſe variation has been, with great reaſon, attributed to the influence which the *iron* on board the ſhip has over the magnetic needle: it was, therefore, natural to conſider, how this main objection might be overcome. The following method has been found, by actual obſervation and experiment, to have the deſired effect:

It is nothing more than fixing a true meridian on the ſhore, out of the reach of the attraction of iron: here the variation is taken by different compaſſes on this meridian; and if they are all true, they give the ſame variation at the ſame time and place; then, before the ſhip ſails, the variation is taken on board, having the ſhip turned, if occaſion ſhould require, on every point of the compaſs; and, by noting the difference between the true variation on the true meridian, and the falſe variation on board, a a table of difference may be conſtructed, which perhaps will always give the allowance neceſſary to be made for falſe variation, throughout any voyage.

It is well known, that on land there is no difficulty in determining the longitude by Jupiter's ſatellites: if the true ſituation of any coaſt, and the ſituation of the magnetic points for any given time, are known, it is eaſy to find the true variation by calculation; ſo that if bodies of iron ore upon the ſea ſhore ſhould even influence the needle, the difference between the variation by calculation and obſervation will conſequently be the allowance for falſe variation: By this method the variation may be very eaſily corrected, with a little care.

Sometimes the variation by amplitude has been different from that by azimuth: this difficulty appears to be removed in a very ſatisfactory manner in Profeſſor Van Swinden's letter, publiſhed in the appendix, to which I muſt beg leave to refer.

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CHAP. IV.

Concerning the Conſtruction of the Magnetic Atlas.

THE main object in view, has been, to prove the principles of the plan; and, as moſt of the places from which the proofs are drawn, are computed from the meridian of Greenwich, I have alſo called this the firſt meridian; ſuppoſing, the obſervations could be compared with leſs trouble on the preſent chart, which is conſtructed in ſuch a manner, that, if the blank gores were cut out, the remainder would fit and cover half a globe, forty-eight inches in circumference. Theſe blank ſpaces, as they become very narrow in the latitude of ſixty, were made to terminate in that degree; whereas, if they had been continued to the pole of the earth, the chart would, conſequently, have been more correct.

Moreover, this method of projecting the ſphere with the magnetic meridians, will perhaps, upon inſpection, be found to ſhew the proportions of each country, as well as the nature of the curves formed by the magnetic meridians, better than upon Mercator's projection, on which the Hallean lines are delineated. As the preſent projection may ſerve not only for a chart, but for covering globes, if occaſion ſhould require.

CHAP. V.

On the Nature of the Magnetic Orbits and Magnetic Meridians.

BY the tables of the places of the two magnetic points, they are repreſented to have an equable and uniform motion; the orbits are likewiſe deſcribed on the chart to be circular; but, as the antient magnetic obſervations ſeldom appear ſo correct as could be deſired,---if future experience ſhould prove them to be in any degree elliptical, the progreſs of the magnetic points, therein, will probably be preciſely conformable thereto. All the earth's meridians are diſtinguiſhed by black lines, and the magnetic meridians by dotted lines. The magnetic meridians are all projected as circular curves, although, as demonſtrated in the magnetic elements, none except two are arches of great circles. If future experience ſhould even prove that the influence of one magnetic point ſhould be greater than that of the other, which ſeems in ſome degree to be the caſe, as this proportion will be better eſtabliſhed by a little more experience, there appears not the leaſt doubt but they will always be included within the moſt rigid rules of calculation: had the encouragement been ſufficient, it would have been highly neceſſary that the ſcale on which the work was laid ſhould have been conſiderably larger in proportion to the radius of the circle, on which the line of chords is conſtructed; for if the radius of this circle had been ſhorter than is delineated on the corner of the magnetic atlas, there would have been an inconveniency; as the odd minutes of magnetic variation could not have been meaſured with ſo much exactneſs: therefore I have conſtructed the lines of chords, ſines, tangents, &c. by a circle, whoſe radius is two inches, being the ſame length as thoſe on Gunter's ſcale. But if any cauſes ſhould occaſion, on the chart, the angle at the place of obſervation between the magnetic meridian and the meridian of the earth to meaſure more or leſs to the northward than the ſouthward, a mean is recommended to be taken for the true variation.

CHAP. VI.

Concerning the Materials from which the Coaſts were laid down.

IT is generally allowed, that the greateſt danger in navigation, is near the coaſt of a country: On this account, every coaſt ſhould be laid down with the greateſt care. I hold myſelf under many obligations, for the aſſiſtance which I have had from the works of many of the moſt able geographers and modern circumnavigators, whoſe labours have been of infinite ſervice in this undertaking; as well on the coaſts of the old world, as of the new diſcoveries: but, as they have alſo been obliged, in many inſtances, to depend on the obſervations of their predeceſſors,---I hope not to be blamed on this account; as this indulgence is univerſally allowable. The Magnetic Atlas may therefore be ſaid to be compoſed, not only from my own knowledge in

America, but alſo from a collection of many works of the beſt authority, and from the moſt accurate aſtronomical obſervations: yet, if any errors ſhould be incorporated therein, they will be beſt rectified by future experience.

CHAP. VII.

Concerning the Southern Hemiſphere, the Magnetic Almanac, &c.

IT appears to be a matter of the moſt conſequence, to publiſh, firſt, the Northern Hemiſphere, as it is navigated much more than the ſouthern; and the truth and utility of this chart will the ſooner be brought to the teſt. However, I have alſo in hand a chart of the Southern Hemiſphere, on the ſame projection; which will be applied to uſe with much more exactneſs, than the preſent,---ſeeing the ſouthern magnetic point is much nigher to the equator of the earth than the northern magnetic point; and conſequently, the variation of the compaſs alters more in the ſouthern hemiſphere, in proportion to the diſtance run.

But if the ſmallneſs of the ſcale, or any combination of cauſes, ſhould conſpire to render theſe charts in any degree imperfect; theſe objections will probably be all overcome, in another new work, to be entitled, THE MAGNETIC ALMANAC, containing an univerſal ſet of tables, ſhewing what latitude and variation correſpond with any part of any meridian; and made eaſy to the moſt common capacity, without the trouble of meaſuring angles: This work has been ſome time preparing for the preſs; and will be the reſult of tens of thouſands of calculations.

CHAP. VIII.

Hints concerning the Cauſe of the Magnetic Variation.

FINDING it now univerſally admitted, that two magnetic points, not diametrically oppoſite to each other, are ſufficient to account for the variation in all the different parts of the earth, and to correſpond with obſervation; there muſt, neceſſarily, be a cauſe for the needle having an univerſal direction towards theſe two magnetic points; and this cauſe muſt either be below the ſurface of the earth, or above the ſame. The celebrated Doctor Halley ſuppoſed the cauſe to be below the ſurface, and communicated by the earth:——but the northern magnetic point is found to move faſter than the earth, from weſt to eaſt, as will appear by the tables. And, as it is an axiom long eſtabliſhed, that "No cauſe can give what it has "not itſelf,"---it is left to the judgment of others, whether, or not, the earth can give a ſwifter motion, than it has itſelf, to a nucleus therein contained. With a view to experiments, I have made ſeveral trials to embark on a voyage to that part of Baffin's Bay, where the north point of the needle is attracted: hoping that ſome obſervations might be made, as well to determine how nearly the variation could be aſcertained, as to throw ſome light on this myſterious principle, in the expectation, that they might probably pave the way to other diſcoveries: and apprehending, likewiſe, there would be no difficulty in ſailing to the northern magnetic point; becauſe navigators have frequently ſailed near five degrees further north, although on another ſide of the globe. I have alſo been induced to contemplate ſuch an undertaking at this time, becauſe this year began with very moderate weather, which continued for the moſt part, ſo very mild, that it is thought, by ſome accurate obſervers, to have been the moſt moderate winter during the memory of man; and therefore it was natural to conclude, firſtly, that there was leſs ice made this winter, than commonly; ſecondly, that the leſs ice there is made in winter, the ſooner it would melt in the ſpring; thirdly, that the ſooner the ice ſhould diſſolve in the ſpring, the longer would be the enſuing ſummer in the northern regions.

Theſe ſeveral concluſions cauſed me to ſtrain every nerve, to perform the propoſed voyage: but, as the publication of the preſent chart had been promiſed a conſiderable time, it was thought it could not, with propriety, be delayed any longer. The deſire of making uſe of this favourable time to go abroad cauſed the work to be too much hurried: ſo that whatever may be the faults in the execution, it is hoped the many reſpectable ſubſcribers, and others, will beſtow upon it their uſual candour, and give it a favourable reception; without ſuppoſing that the principles will be affected thereby. Hoping, on my part, that theſe labours will eventually prove uſeful to mankind; and, by leſſening the dangers of the ſea, that thoſe brave and uſeful citizens who are employed on the watery element, may be ſecured from at leaſt a *part* of the numerous caſualties and diſtreſſes to which they are daily expoſed in navigating the trackleſs ocean; and that I may thus become an humble inſtrument, in the hands of Providence, to prolong the lives of many of my fellow-men.

CHAP. IX.

The Method of proving the Revolutions of the two Magnetic Points.

IT may, perhaps, not be improper to add ſomething concerning the manner in which the periods of the revolutions of the two magnetic points are proved: for this purpoſe, recourſe has been had to actual obſervations of the magnetic variation, made at different times, in both hemiſpheres, at ſeveral places, the ſituations of which have probably been well determined.

1ſtly, In the beginning of the preſent year, 1790, the longitude of the northern magnetic point, as appears by the tables, is calculated to be 80° weſt; the ſouthern magnetic point, in 1787, is found to be 139° 20′ eaſt; and the city of Philadelphia being in latitude 39° 56′ 55″ north, and longitude 75° 13′ 30″ weſt, all computed from Greenwich; the variation of the compaſs here is 1° 57′ weſt; a magnetic meridian drawn from one magnetic point to the other, through the city of Philadelphia, makes an angle with this meridian of 1° 57′, which is found to agree with the real fact.

2dly, In the year 1657, by the tables, the northern magnetic point is placed in 167° 39′ eaſt, and the ſouthern one 147° 54′ eaſt from the ſame meridian. This year, the magnetic needle at Greenwich, or London, pointed due north; and as the magnetic needle is always a tangent to the curve formed by the magnetic meridian, if this curve is drawn for the year 1657, from one magnetic point to the other, through the city of London, the magnetic needle, at that time and place, will be a tangent to the curve; then there will be no angle between the magnetic meridian, thus drawn, and the meridian of London.

3dly, In the year 1642, by the tables, the northern magnetic point was in 154° 59′ eaſt, and the ſouthern one in 148° 54′ eaſt. In this year Taſman viſited Van Diemen's Land, where it is reported by him, that the needle pointed due north. The ſituation of Adventure Bay, in Van Diemen's Land, being aſcertained by Captain Cooke, in the year 1777, to be in 43° 21′ ſouth latitude, and 147° 25′ eaſt longitude: If a curve is drawn from one magnetic point to the other, through Adventure Bay, for the year 1642, this curve will coincide with the meridian of the earth at this bay, as was really the caſe, according to Taſman's obſervation. This will, no doubt, be a ſatisfactory proof, to ſuch who have leiſure to try the experiments; but it may be ſuppoſed, by ſome, that as there was no variation this year at this place, the ſouthern magnetic point muſt have been on the ſame meridian of the place where the magnetic needle points north: if the two magnetic points had been either on the ſame, or on oppoſite meridians, this muſt have been the caſe, according to the foregoing elements; but although they were within 6° 5′ of the ſame meridian, this difference is ſufficient to cauſe the line of no-variation not to be a meridian of the earth. A miſtake of this ſort I at firſt fell into; for on reading that there was no variation at London in the year 1657, I concluded that the northern magnetic point was juſt 180° from that place, without ſufficiently conſidering, that the ſouthern magnetic point was then neither on the ſame nor on oppoſite meridians; which cauſed an error in the revolution of the northern magnetic point, which now ſtands rectified in the preſent chapter: But if, by future obſervations, the period of either ſhould be found not quite ſo exact as the length of a year, this, it is hoped, will be pardonable, ſeeing the preciſe length of a year has not been long determined, notwithſtanding the many volumes of aſtronomical obſervations during ſo many centuries. Thus, having ſufficient data to prove nearly in what parts of their orbits the magnetic points were in former times, the next thing will be to try how near the periods will agree with the tables of the two magnetic points, I ſhall treat firſt of the periodical and ſideral revolution of the northern one. In the beginning of this preſent year, 1790, we find, by calculation, that the northern magnetic point is 80° weſt; and in 1657 it was $167^\circ\ 39'$ eaſt from Greenwich, we have $80^\circ + 167^\circ\ 39' = 247^\circ\ 39'$; then if we take the number of degrees round the earth $360^\circ - 247^\circ\ 39' = 112^\circ\ 21'$. Alſo *Anno Dom.* $1790 - 1657 = 133$ years; then as $112^\circ\ 21' : 360^\circ :: 133^y : 426^y\ 77^d\ 9^h\ 54'$. Then for the ſideral revolution of the northern magnetic point, As $426^y\ 77^d\ 9^h 54' : 360^\circ :: 23^h 56'\ 4'' : 8''\ 18'''\ 9''''$ then we take the length of a ſideral day, $23^h\ 56'\ 4'' - 8''\ 18'''\ 9'''' = 23^h\ 55'\ 55''\ 41'''\ 51''''$; this will be the ſideral revolution required.

Secondly, for the periodical and ſideral revolutions of the ſouthern magnetic point: It is found, by calculation, from the obſervations of Capt. Cooke, in the ſouthern hemiſphere, in the year 1777, that the ſouthern magnetic point was in even numbers 140° eaſt longitude from Greenwich; and by Taſman's obſervation, in the year 1642, a like calculation is made, by which the ſouthern magnetic point is found to be in about $148^\circ\ 54'\ 9''\ 27'''$ eaſt, then we have $148^\circ\ 54'\ 9''\ 27''' - 140^\circ = 8^\circ\ 54'\ 9''\ 27'''$. Likewiſe $1777 - 1642 = 135$ years; then as $8^\circ\ 54'\ 9''\ 27''' : 360^\circ :: 135^y : 5459$ years for the periodical revolution of the ſouthern magnetic point. And for the ſideral revolution of the ſouthern magnetic point, we have the following proportion, viz. As $5459^{yr}_{h} = 172{,}269{,}335{,}460'' : 360^\circ = 77{,}760{,}000''' :: 23\ 56'\ 4'' = 86164'' : 38''' + 23^h\ 56'\ 4'' = 23^h\ 56'\ 4''\ 38'''$ for the ſideral revolution of the ſouthern magnetic point.

CHAP. X.

On the Magnetic Tides.

BESIDES the ever memorable deluges of Noah, Ogyges, and Deucalion, we have innumerable other accounts of the waters of the ocean making leſs remarkable encroachments on the ſhores at particular times and places, and returning to their former bounds. If it were neceſſary, a multitude of inſtances might be produced; though, were I only to hint at one twentieth part of thoſe which might be enumerated, they would far exceed the propoſed bounds of the preſent work. Among the writings of the antient Romans, ſome accounts of this ſort ſtand recorded in Ovid's Metamorphoſes,

" *I've ſeen the ſolid earth transform'd to ſea,*
" *And water alſo turn to ſolid land,*
" *Fiſhes' ſhells lie diſtant from the ocean,*
" *And ruſty anchors on the tops of mountains!*

And Horace ſings, that

" *Fiſhes ſwam in buſhy groves,*
" *Once the well known perch of doves.*

The author of the Hiſtory of the Earth and Animated Nature gives many inſtances confirming the ſame opinion, and adds, that the ſeas being thus ſeen to give and take away lands at pleaſure, is, without queſtion, one of the moſt extraordinary conſiderations in all natural hiſtory. In ſome places, he ſays, it is ſeen to obtain the ſuperiority by ſlow and certain approaches; or to burſt in at once, and overwhelm all things in undiſtinguiſhed deſtruction; in other places it departs from its ſhores, and where its waters have been known to rage, it leaves fields which ſoon become covered with the moſt beautiful verdure; and in another place, "that all this is wonderful; and perhaps, inſtead of attempting to enquire after the cauſe, which has hitherto been inſcrutable, it will beſt become us to reſt ſatisfied with admiration." I have taken ſome pains in making a collection of all the accounts of this ſort within my reach, and find that the low countries, the United Netherlands in particular, have often been overflowed: I ſhall at preſent ſelect only three of the laſt which have happened in that champaign country. The firſt of the three was about the year of our Lord 570, when Turonens ſays, that even the people of part of France were almoſt ſwallowed up by inundations; that Italy alſo ſuffered prodigiouſly, and the whole wall of Lyons was thrown down.

Secondly; Henry the firſt, of England, was born in the year 1068, and in his time there happened a mighty inundation, which extended to Flanders; whereby a great part of that country was irrecoverably loſt, and many of the poor diſtreſſed people, being bereft of their habitations, came over to England; King Henry, taking compaſſion of their diſtreſt condition, and alſo conſidering that they might be beneficial to his ſubjects, by inſtructing them in manufactures, he firſt ſettled them about Carliſle, and afterwards removed them into South Wales, where many of their poſterity are reported by the celebrated Ray to be remaining in his time.

About this time alſo, a large eſtate, or iſland, the patrimony of Earl Goodwin, containing about 4000 acres, was overflowed by the ocean, and was afterwards called the Goodwin ſands.

The laſt inundation of note which happened in Holland, was in the year 1446, when the ſea gradually ſwelled, until it broke in at Dort, and drowned one hundred thouſand perſons, and a greater number about Dullart: two or three hundred villages are declared, by Ray, to have been laid under water, leaving the tops of ſteeples and towers viſible when the tide was out.

If we only contemplate the time between theſe former inundations, and conceive that what has happened heretofore may alſo come about again, may not we then, in the approaching century, at the ſame place, expect the like event?

After collecting various accounts of inundations which have happened in different parts of the world, and in different ages, and after their arrangement in chronological order, there is found a very remarkable agreement between them and the periods of revolution of the magnetic points. Hence, from a variety of deductions, the following concluſions are drawn.

1ſt. That as the periodical revolution of the northern magnetic point is in even numbers, about 426 years, whenever this alone comes on the meridian of any place, the waters of the ocean gradually ſwell to ſuch a degree, as to overflow all low flat lands near its borders, which may be termed a *magnetic tide*.

2d. That as the periodical revolution of the ſouthern magnetic point is about 5,429 years, when the two magnetic points are in conjunction, the ocean ſwells to ſuch a degree, as gradually to cover the high grounds, which may be termed a *magnetic ſpring tide.*

3. That at the times of the deluge of Noah, of Ogyges, and Deucalion, the two magnetic points, from their rate of revolution, were both near the meridian of thoſe places where they happened reſpectively, and never ſince.

According to the beſt accounts, Noah's deluge was 2349 years before the birth of Chriſt, and Deucalion's deluge 1500 years before the ſame period. Then 2349—1500=849—426=423; and as the period of the northern magnetic point is about 426, theſe two deluges make within three years of two revolutions of the northern magnetic point. But the famous deluge of Ogyges happened between that of Noah and Deucalion. Ogyges was King of the Thebans, or, as ſome ſay, of Ogygia and Acte, afterwards Boeotia and Attica; he is recorded to have been the firſt founder of Thebes and Eleuſin: ſome affirm that he periſhed with all his ſubjects 1796 years before Chriſt. In Ray's Phyſico Theological diſcourſes, the deluge of Ogyges is ſaid to have laid waſte the country where it happened, almoſt two hundred years. I therefore ſuſpect the time commonly allowed for that event is the time in which the waters abated, otherwiſe there would have been ſo little time between the deluges of Ogyges and Deucalion as not to diſtinguiſh them apart. The northern magnetic point muſt have been near the meridian of Athens, in Greece, at the deluge of Noah, according to its rate of revolution. Athens is 24° eaſt longitude from Greenwich, and the northern magnetic point in 1790 is 80° weſt from the ſame meridian. We have $80^{\circ}+24^{\circ}=104^{\circ}$; then round the earth is $360^{\circ}-104^{\circ}=256^{\circ}$; likewiſe $360^{\circ}\times 9$ revolutions $=3240^{\circ}+256^{\circ}=3496^{\circ}$. Alſo Noah's deluge before Chriſt $2349+1790=4139$; then as $4139^{y} : 3496^{\circ} :: 1^{y} : 50' \, 40'' \, 44'''$ for its annual rate, which is found to agree with the tables to a minute.

Then, in order to try the agreement of the ſouthern magnetic point, according to its rate of revolution it muſt have been, at the beginning of the deluge of Ogyges, near the meridian of Athens, 24° eaſt longitude from Greenwich, and in 1777 it was 140° eaſt by calculation and the tables; We have $140-24=116$, and the degrees round the globe $360^{\circ}-116^{\circ}=244^{\circ}$ for the number run ſince the deluge of Ogyges. Then from the beginning of this deluge, before Chriſt, $1923^{y}+1777=3700$ years; then as $244^{\circ} : 3700^{y} :: 360^{\circ} : 5459$ years, which agrees exactly with the tables and calculation in the laſt chapter, and I hope none will imagine an inconſiſtency with the dignity of the Deity, in acting by ſecondary cauſes in this caſe, as well as many others.

Diodorus Siculus, in his fifth book, gives an antient ſtory, current among the Samothracians, that before any other floods recorded in hiſtory, there was a very great deluge that overflowed a good part of the coaſt of Aſia, and the lower grounds of its iſlands, when the Euxine ſea firſt broke open the Thracian Boſphorus and Helleſpont, and drowned all the adjacent countries.

Many of the moderns ſeem to think that the account of the great iſland of Atlantis, mentioned by the antients, is not altogether fabulous, and that America agrees to the deſcription thereof; it is reported to have ſunk under water, at a time anſwerable to the two magnetic points being in conjunction on this ſide of the world. The moſt diſtinct account of this extenſive country is mentioned in the Timaeus of Plato, according to the following abridgement. The Atlantis was a large iſland in the Weſtern Ocean, ſituated before or oppoſite to the Straits of Gades (or Cadiz, near Gibraltar.) Out of this iſland there was an eaſy paſſage into ſome others, which lay near a large continent exceeding in greatneſs all Europe and Aſia. Neptune ſettled in this iſland, (from whoſe ſon Atlas its name was derived) and divided it among his ten ſons. To the youngeſt fell the extremity of the iſland called Gadir, which, in the language of the country, ſignifies fertile, or abundant in ſheep. At length, the iſland ſunk under water, and for a long time afterwards the ſea thereabouts was full of rocks and ſhelves.

As the iſthmus of Darien is ſo very narrow, perhaps South America itſelf was the iſland of Atlantis, and North-America nothing leſs than that great continent deſcribed by Plato. It is true that petrified ſea ſhells are often found in layers on high ground, and the natives of this country have a tradition of its being overflowed. Lewis Evans, in a note in his firſt map of the American colonies, declares, we have glaring marks of a deluge in America of a more recent date than thoſe of the old world. Nay, Thomas Jefferſon, Eſq; the Secretary of State, in his notes on Virginia, and Charles Thomſon, Eſq; late Secretary of Congreſs, in an appendix thereto, both give us very pertinent and entertaining remarks on this ſubject. General Lincoln, likewiſe, in a letter to the Preſident of the Univerſity of Cambridge, in Maſſachuſetts, which is publiſhed in the Memoirs of the American Academy of Arts, makes ſome ingenious obſervations pointing the ſame way. To theſe ſeveral valuable works I muſt beg leave to refer.

Since the Settlement of North-America, by Europeans, it is manifeſt that the ſea has made conſiderable encroachments on the land; on the eaſtern coaſt of this country a multitude of evidences are viſible, which agree with this hypotheſis; as in Nova-Scotia the ſtumps of trees are ſeen twenty feet below the common high water mark. On the banks of Delaware river, lives a poor old illiterate man, who has diſtinguiſhed the higheſt tide which has happened every year for many years, by a notch on a tree near the ſhore; he has continued his obſervations, until his marks have mounted one above another in a ſurpriſing manner; and ſome men are ſtill living in Delaware State, who have reaped wheat on grounds which are now converted to ſalt marſh. On Cheſapeak Bay, when the lands were firſt ſurveyed, ſome of them were bounded by marked trees, which then ſtood on dry ground, and now their ſtumps ſtand under water; alſo, in ſome places, where orchards were planted near the ſhore, the waters have encroached to ſuch a degree as to kill the fruit trees: at one place a burying-ground is now part daſhed by the waves, which was once at a diſtance from the ſhore. In Capt. Bernard Romans's Natural Hiſtory of Florida, vol. I. page 20, he deſcribes a number of ſtumps which are only to be ſeen at low water: he believes them to be the ruins of antient foreſts, on which the ſea has made an encroachment.

A Table

OF THE PLACE OF THE NORTHERN MAGNETIC POINT,

For the beginning of each Year, from the time of its leaving the Meridian of Greenwich the laſt time (which was in the Year 1459) until its return to the ſame Meridian again, which will be in the Year 1884, including one full period, or 426 Years, 77 Days, 9 hours, or thereabouts, moving at the rate of 50′ 40″ 44‴ of Longitude in a Year.

After Christ	East.			
	°	′	″	‴
1459	0	25	17	16
1460	1	15	58	00
1461	2	06	38	44
1462	2	57	19	28
1463	3	48	00	12
1464	4	38	40	56
1465	5	29	21	40
1466	6	20	02	24
1467	7	10	43	08
1468	8	01	23	52
1469	8	52	04	36
1470	9	42	45	20
1471	10	33	26	04
1472	11	24	06	48
1473	12	14	47	32
1474	13	05	28	16
1475	13	56	09	00
1476	14	46	49	44
1477	15	37	20	28
1478	16	28	11	12
1479	17	18	51	56
1480	18	09	32	40
1481	19	00	13	24
1482	19	50	54	28
1483	20	41	34	52
1484	21	32	15	36
1485	22	22	56	20
1486	23	13	37	04
1487	24	04	17	48
1488	24	54	58	32
1489	25	45	39	16
1490	26	36	20	00
1401	27	27	00	44
1492	28	17	41	28
1493	29	08	22	12
1494	29	59	02	56
1495	30	49	43	40
1496	31	40	24	24
1497	32	31	05	08
1498	33	21	45	52
1499	34	12	26	36
1500	35	03	07	20
1501	35	53	48	04
1502	36	44	28	48
1503	37	35	09	32
1504	38	25	50	16
1505	29	16	21	00
1506	40	07	11	44
1507	40	57	52	28
1508	41	48	33	12
1509	42	29	13	56
1510	43	20	54	40
1511	44	20	35	24
1512	45	11	16	08
1513	46	01	56	52
1514	46	52	37	36

After Christ	East.			
	°	′	″	‴
1514	46	52	37	36
1515	47	43	18	20
1516	48	33	59	04
1517	49	24	39	48
1518	50	15	20	32
1519	51	06	01	16
1520	51	56	42	00
1521	52	47	22	44
1522	53	38	03	28
1523	54	28	44	12
1524	55	19	24	56
1525	56	10	05	40
1526	57	00	46	24
1527	57	51	27	08
1528	58	42	07	52
1529	59	32	48	36
1530	60	23	29	20
1531	61	14	10	04
1532	62	04	50	48
1533	62	55	31	32
1534	63	46	12	16
1535	64	36	53	00
1536	65	27	33	44
1537	66	18	14	28
1538	67	08	55	12
1539	67	59	35	56
1540	68	50	16	40
1541	69	40	57	24
1542	70	31	38	08
1543	71	22	18	52
1544	72	12	59	36
1545	73	03	40	20
1546	73	54	21	04
1547	74	45	01	48
1548	75	35	42	32
1549	76	26	23	16
1550	77	17	04	00
1551	78	07	44	44
1552	78	58	25	28
1553	79	49	06	12
1554	80	39	46	56
1555	81	30	27	40
1556	82	21	08	24
1557	83	11	49	08
1558	84	02	29	52
1559	84	53	10	36
1560	85	43	51	20
1561	86	34	32	04
1562	87	25	12	48
1563	88	15	53	32
1564	89	06	34	16
1565	89	57	15	00
1566	90	49	55	44
1567	91	38	36	28
1568	92	29	17	12
1569	93	19	57	56

After Christ	East.			
	°	′	″	‴
1570	94	10	38	40
1571	95	01	19	24
1572	95	52	00	08
1573	96	42	40	52
1574	97	33	21	36
1575	98	24	02	20
1576	99	14	43	04
1577	100	05	23	48
1578	100	56	04	32
1579	101	46	45	16
1580	102	37	26	00
1581	103	28	06	44
1582	104	18	47	28
1583	105	09	28	12
1584	106	00	08	56
1585	106	50	49	40
1586	107	41	30	24
1587	108	32	11	08
1588	109	22	51	52
1589	110	13	32	36
1590	111	04	13	20
1591	111	54	54	04
1592	112	45	34	48
1593	113	36	15	32
1594	114	26	56	16
1595	115	17	37	00
1596	116	08	17	44
1597	116	58	58	28
1598	117	49	39	12
1599	118	40	19	56
1600	119	31	00	40
1601	120	21	41	24
1602	121	12	22	08
1603	122	03	02	52
1604	122	53	43	36
1605	123	44	24	20
1606	124	35	05	04
1607	125	25	45	48
1608	126	16	26	32
1609	127	07	07	16
1610	127	57	48	00
1611	128	48	28	44
1612	129	39	09	28
1613	130	29	50	12
1614	131	20	30	56
1615	132	11	11	40
1616	133	01	52	24
1617	133	52	33	08
1618	134	43	13	52
1619	135	33	54	36
1620	136	24	35	20
1621	137	15	16	04
1622	138	05	56	48
1623	138	56	37	32
1624	139	47	18	16
1625	140	37	59	00

After Christ	East.			
	°	′	″	‴
1625	140	37	59	00
1626	141	28	39	44
1627	142	19	20	28
1628	143	10	01	12
1629	144	00	41	56
1630	144	51	22	40
1631	145	42	03	24
1632	146	32	44	08
1633	147	23	24	52
1634	148	14	05	36
1635	149	04	46	20
1636	149	55	27	04
1637	150	46	07	48
1638	151	36	48	32
1639	152	27	29	16
1640	153	18	10	00
1641	154	08	50	44
1642	154	59	31	28
1643	155	50	12	12
1644	156	40	52	56
1645	157	31	33	40
1646	158	22	14	24
1647	159	12	55	08
1648	160	03	35	52
1649	160	54	16	36
1650	161	44	57	20
1651	162	35	38	04
1652	163	26	18	48
1653	164	16	59	32
1654	165	07	40	16
1655	165	58	21	00
1656	166	49	01	44
1657	167	39	42	28
1658	168	30	23	12
1659	169	21	03	56
1660	170	11	44	40
1661	171	02	25	24
1662	171	53	06	08
1663	172	43	46	52
1664	173	34	27	36
1665	174	25	08	20
1666	175	15	49	04
1667	176	06	29	48
1668	176	57	10	32
1669	177	47	51	16
1670	178	38	32	00
1671	179	29	12	44

After Christ	West.			
	°	′	″	‴
1672	179	40	06	32
1673	178	49	25	48
1674	177	58	45	04
1675	177	08	04	20
1676	176	17	23	36
1677	175	26	42	52
1678	174	36	02	08
1679	173	45	21	24
1680	172	54	40	40
1681	172	03	59	56
1682	171	13	19	12
1683	170	22	38	28
1684	169	31	57	44
1685	168	41	17	00
1686	167	50	36	16
1687	166	59	55	32
1688	166	09	14	48
1689	165	18	34	04
1690	164	27	53	20
1691	163	37	12	36
1692	162	46	31	52
1693	161	55	51	08
1694	161	05	10	24
1695	160	14	29	40
1696	159	23	48	56
1697	158	33	08	12
1698	157	42	27	28
1699	156	51	46	44
1700	156	01	06	00
1701	155	10	25	16
1702	154	19	44	32
1703	153	29	03	48
1704	152	38	22	04
1705	151	47	42	20
1706	150	57	01	36
1707	150	06	20	52
1708	149	15	40	08
1709	148	24	59	24
1710	147	34	18	40
1711	146	43	37	56
1712	145	52	57	12
1713	145	02	16	28
1714	144	11	35	44
1715	143	20	55	00
1716	142	30	14	16
1717	141	39	33	32
1718	140	48	52	48
1719	139	58	12	04
1720	139	07	31	20
1721	138	16	50	36
1722	137	26	09	52
1723	136	35	29	08
1724	135	44	48	24
1725	134	54	07	40
1726	134	03	26	56
1727	133	12	46	12

After Christ	West.			
	°	′	″	‴
1727	133	12	46	12
1728	132	22	05	28
1729	131	31	24	44
1730	130	40	44	00
1731	129	50	03	16
1732	128	59	22	32
1733	128	08	41	48
1734	127	18	01	04
1735	126	27	20	20
1736	125	36	39	36
1737	124	45	58	52
1738	123	55	18	08
1739	123	04	37	24
1740	122	13	56	40
1741	121	23	15	56
1742	120	32	35	12
1743	119	41	54	28
1744	118	51	13	44
1745	118	00	33	00
1746	117	09	52	16
1747	116	19	11	32
1748	115	28	30	48
1749	114	37	50	04
1750	113	47	09	20
1751	112	56	28	36
1752	112	05	47	52
1753	111	15	07	08
1754	110	24	26	24
1755	109	33	45	40
1756	108	43	04	56
1757	107	52	24	12
1758	107	01	43	28
1759	106	11	02	44
1760	105	20	22	00
1761	104	29	41	16
1762	103	39	00	32
1763	102	48	19	48
1764	101	57	39	04
1765	101	06	58	20
1766	100	16	17	36
1767	99	25	36	52
1768	98	34	56	08
1769	97	44	15	24
1770	96	53	34	40
1771	96	02	53	56
1772	95	12	13	12
1773	94	21	32	28
1774	93	30	51	44
1775	92	40	11	00
1776	91	49	30	16
1777	90	58	49	32
1778	90	08	08	48
1779	89	17	28	04
1780	88	26	47	20
1781	87	36	06	36
1782	86	45	25	52

After Christ	West.			
	°	′	″	‴
1782	86	45	25	52
1783	85	54	45	08
1784	85	04	04	24
1785	84	13	23	40
1786	83	22	42	56
1787	82	32	02	12
1788	81	41	21	28
1789	80	50	40	44
1790	80	00	00	00
1791	79	09	19	16
1792	78	18	38	32
1793	77	27	57	48
1794	76	37	17	04
1795	75	46	36	20
1796	74	55	55	36
1797	74	05	14	52
1798	73	14	34	08
1799	72	23	53	24
1800	71	33	12	40
1801	70	42	31	56
1802	69	51	51	12
1803	69	01	10	28
1804	68	10	29	44
1805	67	19	49	00
1806	66	29	08	16
1807	65	38	27	32
1808	64	47	46	48
1809	63	57	06	04
1810	63	06	25	20
1811	62	15	44	36
1812	61	25	03	52
1813	60	34	23	08
1814	59	43	42	24
1815	58	53	01	40
1816	58	02	20	56
1817	[illegible]	[illegible]	40	12
1818	[illegible]	20	59	28
1819	[illegible]	[illegible]	18	44
1820	[illegible]	[illegible]	38	00
1821	[illegible]	[illegible]	57	16
1822	[illegible]	[illegible]	16	32
1823	[illegible]	[illegible]	35	48
1824	[illegible]	[illegible]	55	04
1825	[illegible]	[illegible]	14	20
1826	[illegible]	[illegible]	33	36
1827	[illegible]	[illegible]	52	52
1828	[illegible]	[illegible]	12	08
1829	47	[illegible]	31	24
1830	46	[illegible]	50	40
1831	45	[illegible]	09	56
1832	44	[illegible]	20	12
1833	43	[illegible]	48	28
1834	42	[illegible]	07	44
1835	41	[illegible]	27	00
1836	41	[illegible]	46	16
1837	[illegible]	[illegible]	05	32

After Christ	West.			
	°	′	″	‴
1837	40	18	05	32
1838	39	27	24	48
1839	38	36	44	04
1840	37	46	03	20
1841	36	55	22	36
1842	36	04	41	52
1843	35	1	01	08
1844	34	23	20	24
1845	33	32	39	40
1846	32	41	58	56
1847	31	51	18	12
1848	31	00	37	28
1849	30	09	56	44
1850	29	19	16	00
1851	28	28	35	16
1852	27	37	54	32
1853	26	47	13	48
1854	25	56	33	04
1855	25	05	52	20
1856	24	15	11	36
1857	23	24	30	52
1858	22	33	50	08
1859	21	43	09	24
1860	20	52	29	40
1861	20	01	47	56
1862	19	11	07	12
1863	18	20	26	28
1864	17	29	45	44
1865	16	39	05	00
1866	15	48	24	16
1867	14	57	43	22
1868	14	07	02	48
1869	13	16	22	04
1870	12	25	41	20
1871	11	35	00	36
1872	10	44	19	52
1873	9	53	39	08
1874	9	02	58	24
1875	8	12	17	40
1876	7	21	36	56
1877	6	30	56	12
1878	5	40	15	28
1870	4	49	34	44
1880	3	58	54	00
1881	3	08	13	16
1882	2	17	32	32
1883	1	26	51	48
1884	0	36	11	04

A Table

OF THE PLACE OF THE SOUTHERN MAGNETIC POINT,

From within a Century of the time of the Creation (according to the Moſaic account) until the year of our Lord 3877, including a period of 7800 Years, as it is found to change its place, at the rate of 6° 35′ 40″ 32‴ in a hundred Years, the Longitude computed from the Meridian of Greenwich,

Before Chriſt	East. °	′	″	‴
3923	155	33	30	40
3823	149	17	50	08
3723	142	42	09	36
3623	136	06	29	04
3523	129	30	48	32
3423	122	55	08	00
3323	116	19	27	28
3223	109	43	46	56
3123	103	08	06	24
3023	96	32	25	52
2923	89	56	45	20
2823	83	21	04	48
2723	76	45	24	16
2623	70	09	43	44
2523	63	34	03	12
2423	56	58	22	40
2323	50	22	42	08
2223	43	47	01	36
2123	37	11	21	04
2023	30	35	40	32
1923	24	00	00	00
1823	17	24	19	28
1723	10	48	38	56
1623	04	12	58	24
	West.			
1523	02	22	42	08
1423	08	58	22	40
1323	15	34	03	12
1223	22	09	43	44
1123	28	45	24	16
1023	35	21	04	48
923	41	56	45	20
823	48	32	25	52
723	55	08	06	24
623	61	43	46	56
523	68	19	27	28
423	74	55	08	00
323	81	31	48	32
223	88	06	29	04
123	94	42	09	36
23	101	17	50	08

After Chriſt	West. °	′	″	‴
77	107	53	30	40
177	114	29	11	12
277	121	04	51	44
377	127	40	32	16
477	134	16	12	48
577	140	51	53	20
677	147	27	33	52
777	154	03	14	24
877	160	28	54	56
977	167	14	35	28
1077	173	50	16	00
1177	179	34	03	28
	East.			
1277	172	58	22	46
1377	166	22	42	14
1477	159	47	01	42

After Chriſt	East. °	′	″	‴
1482	159	27	14	41
1487	159	07	27	40
1492	158	47	40	39
1497	158	27	53	38
1502	158	08	06	37
1507	157	48	19	36
1512	157	28	32	35
1517	157	08	45	34
1522	156	48	58	33
1527	156	29	11	32
1532	156	09	24	31
1537	155	49	37	30
1542	155	29	50	29
1547	155	00	03	28
1552	154	50	16	27
1557	154	30	29	26
1562	154	10	42	25
1567	153	50	45	24
1572	153	31	08	23
1577	153	11	21	22
1582	152	51	34	21
1587	152	31	47	20
1592	152	12	00	19
1597	151	52	13	18
1602	151	32	26	17
1607	151	12	39	16
1612	150	52	52	15
1617	150	33	05	14
1622	150	13	18	13
1627	149	53	30	30
1632	149	33	43	29
1637	149	13	56	28
1642	148	54	09	27
1647	148	34	22	26
1652	148	14	35	25
1657	147	54	48	24
1662	147	35	01	23
1667	147	15	14	22
1672	146	55	27	21
1677	146	35	40	20

After Chriſt	East. °	′	″	‴
1682	146	15	53	19
1687	145	56	06	18
1692	145	36	19	17
1697	145	16	32	16
1702	144	56	45	15
1707	144	36	58	14
1712	144	17	11	13
1717	143	57	24	12
1722	143	37	37	11
1727	143	17	50	10
1732	142	58	03	09
1737	142	38	16	08
1742	142	18	29	07
1747	141	58	42	06
1752	141	38	55	05
1757	141	19	08	04
1762	140	59	21	03
1767	140	39	34	02
1772	140	19	47	01
1777	140	00	00	00
1782	139	40	12	59
1787	139	20	25	58
1792	139	00	38	57
1797	138	40	51	56
1802	138	21	04	55
1807	138	01	17	54
1812	137	41	30	53
1817	137	21	43	52
1822	137	01	56	51
1827	136	42	09	50
1832	136	22	22	49
1837	136	02	35	48
1842	135	42	48	47
1847	135	23	01	46
1852	135	03	14	45
1857	134	43	27	44
1862	134	23	40	43
1867	134	03	53	42
1872	133	44	06	41

After Chriſt	East. °	′	″	‴
1877	133	24	19	40
1977	126	48	39	02
2077	120	12	58	30
2177	113	37	17	58
2277	107	01	37	26
2377	100	25	56	54
2477	93	50	16	22
2577	87	14	35	50
2677	80	38	45	18
2777	74	03	14	46
2877	67	27	34	14
2977	60	51	53	42
3077	54	16	13	10
3177	47	40	32	38
3277	41	04	52	06
3377	34	29	11	34
3477	27	53	31	02
3577	21	17	50	30
3677	14	42	09	58
3777	8	06	29	26
3877	1	30	48	54

N. B. The foregoing calculations, for the Southern Magnetic point, are computed for the beginning of each Year.

A Table

OF THE PLACE OF THE NORTHERN MAGNETIC POINT,

For the beginning of each Year, from the time of its leaving the Meridian of Greenwich the laſt time (which was in the Year 1459) until its return to the ſame Meridian again, which will be in the Year 1884, including one full period, or 426 Years, 77 Days, 9 hours, or thereabouts, moving at the rate of 50′ 40″ 44‴ of Longitude in a Year.

After Christ	Eaſt.			
	°	′	″	‴
1459	0	25	17	16
1460	1	15	58	00
1461	2	06	38	44
1462	2	57	19	28
1463	3	48	00	12
1464	4	38	40	56
1465	5	29	21	40
1466	6	20	02	24
1467	7	10	43	08
1468	8	01	23	52
1469	8	52	04	36
1470	9	42	45	20
1471	10	33	26	04
1472	11	24	06	48
1473	12	14	47	32
1474	13	05	28	16
1475	13	56	09	00
1476	14	46	49	44
1477	15	37	30	28
1478	16	28	11	12
1479	17	18	51	56
1480	18	09	32	40
1481	19	00	13	24
1482	19	50	54	28
1483	20	41	34	52
1484	21	32	15	36
1485	22	22	56	20
1486	23	13	37	04
1487	24	04	17	48
1488	24	54	58	32
1489	25	45	39	16
1490	26	36	20	00
1401	27	27	00	44
1492	28	17	41	28
1493	29	08	22	12
1494	29	59	02	56
1495	30	49	43	40
1496	31	40	24	24
1497	32	31	05	08
1498	33	21	45	52
1499	34	12	26	36
1500	35	03	07	20
1501	35	53	48	04
1502	36	44	28	48
1503	37	35	09	32
1504	38	25	50	16
1505	39	16	31	00
1506	40	07	11	44
1507	40	57	52	28
1508	41	48	33	12
1509	42	39	13	56
1510	43	29	54	40
1511	44	20	35	24
1512	45	11	16	08
1513	46	01	56	52
1514	46	52	37	36

After Christ	Eaſt.			
	°	′	″	‴
1514	46	52	37	36
1515	47	43	18	20
1516	48	33	59	04
1517	49	24	39	48
1518	50	15	20	32
1519	51	06	01	16
1520	51	56	42	00
1521	52	47	22	44
1522	53	38	03	28
1523	54	28	44	12
1524	55	19	24	56
1525	56	10	05	40
1526	57	00	46	24
1527	57	51	27	08
1528	58	42	07	52
1529	59	32	48	36
1530	60	23	29	20
1531	61	14	10	04
1532	62	04	50	48
1533	62	55	31	32
1534	63	46	12	16
1535	64	36	53	00
1536	65	27	33	44
1537	66	18	14	28
1538	67	08	55	12
1539	67	59	35	56
1540	68	50	16	40
1541	69	40	57	24
1542	70	31	38	08
1543	71	22	18	52
1544	72	12	59	36
1545	73	03	40	20
1546	73	54	21	04
1547	74	45	01	48
1548	75	35	42	32
1549	76	26	23	16
1550	77	17	04	00
1551	78	07	44	44
1552	78	58	25	28
1553	79	49	06	12
1554	80	39	46	56
1555	81	30	27	40
1556	82	21	08	24
1557	83	11	49	08
1558	84	02	29	52
1559	84	53	10	36
1560	85	43	51	20
1561	86	34	32	04
1562	87	25	12	48
1563	88	15	53	32
1564	89	06	34	16
1565	89	57	15	00
1566	90	47	55	44
1567	91	38	36	28
1568	92	29	17	12
1569	93	19	57	56

After Christ	Eaſt.			
	°	′	″	‴
1570	94	10	38	40
1571	95	01	19	24
1572	95	52	00	08
1573	96	42	40	52
1574	97	33	21	36
1575	98	24	02	20
1576	99	14	43	04
1577	100	05	23	48
1578	100	56	04	32
1579	101	46	45	16
1580	102	37	26	00
1581	103	28	06	44
1582	104	18	47	28
1583	105	09	28	12
1584	106	00	08	56
1585	106	50	49	40
1586	107	41	30	24
1587	108	32	11	08
1588	109	22	51	52
1589	110	13	32	36
1590	111	04	13	20
1591	111	54	54	04
1592	112	45	34	48
1593	113	36	15	32
1594	114	26	56	16
1595	115	17	37	00
1596	116	08	17	44
1597	116	58	58	28
1598	117	49	39	12
1599	118	40	19	56
1600	119	31	00	40
1601	120	21	41	24
1602	121	12	22	08
1603	122	03	02	52
1604	122	53	43	36
1605	123	44	24	20
1606	124	35	05	04
1607	125	25	45	48
1608	126	16	26	32
1609	127	07	07	16
1610	127	57	48	00
1611	128	48	28	44
1612	129	39	09	28
1613	130	29	50	12
1614	131	20	30	56
1615	132	11	11	40
1616	133	01	52	24
1617	133	52	33	08
1618	134	43	13	52
1619	135	33	54	36
1620	136	24	35	20
1621	137	15	16	04
1622	138	05	56	48
1623	138	56	37	32
1624	139	47	18	16
1625	140	37	59	00

After Christ	Eaſt.			
	°	′	″	‴
1625	140	37	59	00
1626	141	28	39	44
1627	142	19	20	28
1628	143	10	01	12
1629	144	00	41	56
1630	144	51	22	40
1631	145	42	03	24
1632	146	32	44	08
1633	147	23	24	52
1634	148	14	05	36
1635	149	04	46	20
1636	149	55	27	04
1637	150	46	07	48
1638	151	36	48	32
1639	152	27	29	16
1640	153	18	10	00
1641	154	08	50	44
1642	154	59	31	28
1643	155	50	12	12
1644	156	40	52	56
1645	157	31	33	40
1646	158	22	14	24
1647	159	12	55	08
1648	160	03	35	52
1649	160	54	16	36
1650	161	44	57	20
1651	162	35	38	04
1652	163	26	18	48
1653	164	16	59	32
1654	165	07	40	16
1655	165	58	21	00
1656	166	49	01	44
1657	167	39	42	28
1658	168	30	23	12
1659	169	21	03	56
1660	170	11	44	40
1661	171	02	25	24
1662	171	53	06	08
1663	172	43	46	52
1664	173	34	27	36
1665	174	25	08	20
1666	175	15	49	04
1667	176	06	29	48
1668	176	57	10	32
1669	177	47	51	16
1670	178	38	32	00
1671	179	29	12	44

After Christ	Weſt.			
	°	′	″	‴
1672	179	40	06	32
1673	178	49	25	48
1674	177	58	45	04
1675	177	08	04	20
1676	176	17	23	36
1677	175	26	42	52
1678	174	36	02	08
1679	173	45	21	24
1680	172	54	40	40
1681	172	03	59	56
1682	171	13	19	12
1683	170	22	38	28
1684	169	31	57	44
1685	168	41	17	00
1686	167	50	36	16
1687	166	59	55	32
1688	166	09	14	48
1689	165	18	34	04
1690	164	27	53	20
1691	163	37	12	36
1692	162	46	31	52
1693	161	55	51	08
1694	161	05	10	24
1695	160	14	29	40
1696	159	23	48	56
1697	158	33	08	12
1698	157	42	27	28
1699	156	51	46	44
1700	156	01	06	00
1701	155	10	25	16
1702	154	19	44	32
1703	153	29	03	48
1704	152	38	23	04
1705	151	47	42	20
1706	150	57	01	36
1707	150	06	20	52
1708	149	15	40	08
1709	148	24	59	24
1710	147	34	18	40
1711	146	43	37	56
1712	145	52	57	12
1713	145	02	16	28
1714	144	11	35	44
1715	143	20	55	00
1716	142	30	14	16
1717	141	39	33	32
1718	140	48	52	48
1719	139	58	12	04
1720	139	07	31	20
1721	138	16	50	36
1722	137	26	09	52
1723	136	35	29	08
1724	135	44	48	24
1725	134	54	07	40
1726	134	03	26	56
1727	133	12	46	12

After Christ	Weſt.			
	°	′	″	‴
1727	133	12	46	12
1728	132	22	05	28
1729	131	31	24	44
1730	130	40	44	00
1731	129	50	03	16
1732	128	59	22	32
1733	128	08	41	48
1734	127	18	01	04
1735	126	27	20	20
1736	125	36	39	36
1737	124	45	58	52
1738	123	55	18	08
1739	123	04	37	24
1740	122	13	56	40
1741	121	23	15	56
1742	120	32	35	12
1743	119	41	54	28
1744	118	51	13	44
1745	118	00	33	00
1746	117	09	52	16
1747	116	19	11	32
1748	115	28	30	48
1749	114	37	50	04
1750	113	47	09	20
1751	112	56	28	36
1752	112	05	47	52
1753	111	15	07	08
1754	110	24	26	24
1755	109	33	45	40
1756	108	43	04	56
1757	107	52	24	12
1758	107	01	43	28
1759	106	11	02	44
1760	105	20	22	00
1761	104	29	41	16
1762	103	39	00	32
1763	102	48	19	48
1764	101	57	39	04
1765	101	06	58	20
1766	100	16	17	36
1767	99	25	36	52
1768	98	34	56	08
1769	97	44	15	24
1770	96	53	34	40
1771	96	02	53	56
1772	95	12	13	12
1773	94	21	32	28
1774	93	30	51	44
1775	92	40	11	00
1776	91	49	30	16
1777	90	58	49	32
1778	90	08	08	48
1779	89	17	28	04
1780	88	26	47	20
1781	87	36	06	36
1782	86	45	25	52

After Christ	Weſt.			
	°	′	″	‴
1782	86	45	25	52
1783	85	54	45	08
1784	85	04	04	24
1785	84	13	23	40
1786	83	22	42	56
1787	82	32	02	12
1788	81	41	21	28
1789	80	50	40	44
1790	80	00	00	00
1791	79	09	19	16
1792	78	18	38	32
1793	77	27	57	48
1794	76	37	17	04
1795	75	46	36	20
1796	74	55	55	36
1797	74	05	14	52
1798	73	14	34	08
1799	72	23	53	24
1800	71	33	12	40
1801	70	42	31	56
1802	69	51	51	12
1803	69	01	10	28
1804	68	10	29	44
1805	67	19	49	00
1806	66	29	08	16
1807	65	38	27	32
1808	64	47	46	48
1809	63	57	06	04
1810	63	06	25	20
1811	62	15	44	36
1812	61	25	03	52
1813	60	34	23	08
1814	59	43	42	24
1815	58	53	01	40
1816	58	02	20	56
1817	[illegible]	11	40	12
1818	[illegible]	[illegible]	59	28
1819	[illegible]	[illegible]	18	44
1820	[illegible]	[illegible]	38	00
1821	[illegible]	[illegible]	57	16
1822	52	[illegible]	16	32
1823	[illegible]	[illegible]	35	48
1824	[illegible]	[illegible]	55	04
1825	[illegible]	[illegible]	14	20
1826	[illegible]	[illegible]	33	36
1827	[illegible]	[illegible]	52	52
1828	[illegible]	[illegible]	12	08
1829	47	[illegible]	31	24
1830	46	[illegible]	50	40
1831	45	[illegible]	09	56
1832	44	[illegible]	29	12
1833	43	[illegible]	48	28
1834	42	[illegible]	07	44
1835	41	[illegible]	27	00
1836	41	[illegible]	46	16
1837	[illegible]	[illegible]	05	32

After Christ	Weſt.			
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1837	40	18	05	32
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1843	35	14	01	08
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1847	31	51	18	12
1848	31	00	37	28
1849	30	09	56	44
1850	29	19	16	00
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1852	27	37	54	32
1853	26	47	13	48
1854	25	56	33	04
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1861	20	01	47	56
1862	19	11	07	12
1863	18	20	26	28
1864	17	29	45	44
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1868	14	07	02	48
1869	13	16	22	04
1870	12	25	41	20
1871	11	35	00	36
1872	10	44	19	52
1873	9	53	39	08
1874	9	02	58	24
1875	8	12	17	40
1876	7	21	36	56
1877	6	30	56	12
1878	5	40	15	28
1879	4	49	34	44
1880	3	58	54	00
1881	3	08	13	16
1882	2	17	32	32
1883	1	26	51	48
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APPENDIX.

Having received a conſiderable number of letters on the ſubject of the foregoing tract, from perſons of eminence; for brevity's ſake, only a few are inſerted.

LETTER I.

From the American Miniſter and Plenipotentiary at the Court of France.

PARIS, August 8th, 1787.

SIR,

I HAVE duly received your favour of June 6th, and immediately communicated its contents to a member of the Academy.* He told me they had received the other copy of your memorial, which you mention to have ſent through another channel; that your ideas were not conveyed ſo explicitly as to enable them to decide *finally* on their merit; but that they had made an entry on their Journals, to preſerve to you the claim to the *original* idea. As far as we can conjecture it here, we imagine you make a table of variations of the needle, for all the different meridians whatever. To apply this table to uſe, in a voyage between America and Europe,—ſuppoſe the variation to increaſe a degree in every 160 miles,—two difficulties occur: 1ſt, a ready and accurate method of finding the variation of the place; 2d, an inſtrument, ſo perfect as that (though the degree on it ſhall repreſent 160 miles) it ſhall give the parts of the degree, ſo minutely as to anſwer the purpoſes of the navigator. The variation of the needle at Paris actually is 21° Weſt. I make no doubt but you have provided againſt the doubts entertained here; and I ſhall be happy that our country may have the honour of furniſhing the old world, what it has ſo long ſought in vain. I am, with much reſpect,

Sir, your moſt obedient humble ſervant,

THOMAS JEFFERSON.

Mr. John Churchman, Philadelphia.

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* *The Royal Academy of Sciences.*

LETTER II.

From Sir Joſeph Banks, Bart. Preſident of the Royal Society of London.

Soho Square, Sept. 1ſt, 1787.

SIR,

I HAVE received your ingenious letter relative to the variation of the needle, and take the liberty of adviſing you to purſue, with diligence, a ſubject on which it appears to me you have made a progreſs, ſufficient to authorize a reaſonable hope, that ſcience will derive real increaſe from your labours.

The Royal Society having lately removed into a new houſe, the firſt ſeries of obſervations relative to the variation is only now in its courſe. I cannot therefore tell you with the utmoſt preciſion what the variation is there; our inſtrument at preſent gives 23° 8′ Weſt, which probably is ſufficiently exact for your purpoſe: preſently, when the inſtrument is moved, we ſhall find if the magnetiſm of the building has any material effect upon it, of which, if it has, I ſhall with pleaſure inform you. I am, Sir,

Your obedient and moſt humble ſervant,

JOS: BANKS.

Mr. John Churchman.

LETTER III.

From the Houſe of Delegates in Maryland, dated at Annapolis, in December, 1787.

SIR,

I AM commanded, by the Honourable Houſe of Delegates, to return you their thanks, for your communication and explanation of your ideas, relative to the principles of magnetiſm, and their application in regulating the ſurveys of land; and I, with pleaſure, return you the thanks of the Houſe accordingly. I am, &c. &c.

THOMAS C. DEYE.

Speaker of the Houſe of Delegates.

To **John Churchman**, Eſq.

LETTER IV.

From Sir H. Parker, Bart. Secretary to the Board of Longitude in Great-Britain.

Admiralty, 20th Dec. 1787.

SIR,

I HAD the honour, at the meeting of the Commiſſioners of Longitude, the 8th of this month, to lay before them the memorial you ſome time ſince tranſmitted to me, ſtating, that you have diſcovered certain fixed principles in magnetiſm, which will aſcertain, to a great preciſion, the longitude of places in all parts of the globe, &c.: and I am directed to acquaint you, the Board have the ſubject matter of your ſaid memorial under conſideration and will take an early opportunity of giving you their ſentiments upon what you have ſubmitted to them. I am, Sir,

Your moſt humble ſervant,

H. PARKER, Sec'ry to the Commiſſioners of Longitude.

Mr. John Churchman,
Philadelphia.

LETTER V.

An extract of one, from Charles Blagden, M. D. Secretary to the Royal Society of London.

London, July 6, 1789.

SIR,

I HAVE received your letter, with the encloſed addreſs,* and preſented the letter to the Royal Society, who deſired their thanks to be returned for the ſame. It is contrary to the rules of the Society to read before them printed papers, or ſuch as are known to have been communicated to other learned bodies. The rumour of Sir Joſeph Banks's death was without foundation: he is here in good health, and informs me, that your three letters[†] are in his poſſeſſion.

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* An addreſs to the members of the different learned ſocieties, ſhewing the deficiencies in profeſſer Eulers memoir on this ſubject, ſee American Muſeum for May 1789.

[†] *Three letters on other ſubjects, duplicates of which were addreſſed to Comte de Caſſini, Director of the Royal Obſervatory at Paris.*

LETTER VI.

From the American Miniſter and Plenipotentiary at the Court of France.

PARIS, SEPT. 18th, 1789.

SIR,

I HAVE duly received your favour of the 15th of May. I had before received, and anſwered, the firſt letter you wrote me; but the ſecond, which you mention to have written, never came to hand. I have ſent to the Secretary of the Academy of Sciences the [‡] printed paper encloſed in your laſt. I aſked at the ſame time the authenticated [§] copy, which you deſired, of the entry on their Journals, relative to your former communications to them. This I now encloſe to you, as I received it from the Marquis de Condorcet, their Secretary. Being about to leave this country, on a viſit to my own, I ſhall be in hopes of perhaps meeting you ſome where in my tour; and of expreſſing to you, in perſon, my readineſs, on all occaſions, to be uſeful to you, in the buſineſs now in hand, and the ſentiments of eſteem with which I am, Sir,

Your moſt obedient humble ſervant,

THO. JEFFERSON.

Mr. CHURCHMAN.

[§] *Copy of the entry on the Journals of the Royal Academy of Sciences above mentioned:*

"La lettre de M. Churchman, de Philadelphie, ſur la variation de l'aiman, "à eté lue à l'Academie des Sciences de Paris, le 16 Juin, 1787.

"Je certifiê cet extrait conforme aux regiſtres de l'Academié à Paris, "le 15 Septembre, 1789.

"LE MARQUIS DE CONDORCET."

LETTER VII.

From Nicholas Van Staphorſt, Eſq; of Holland.

Mr. JOHN CHURCHMAN, in Philadelphia,

AMSTERDAM, 22d OCTOBER, 1789.

SIR,

I RECEIVED, in due time, your very eſteemed favour of 17th April, with the printed addreſs [‡] mentioned therein, which I with great pleaſure laid before my worthy friend, Profeſſor Van Swinden, whoſe obſervations thereon you will have in the encloſed remarks from him, in French and Engliſh. The works he alludes to, I forward in a packet, by this conveyance, to Mr. George Mead, of your city, to be delivered to you; and ſincerely wiſhing they may prove to your ſatisfaction. I am, with every diſpoſition to render you the uſeful or agreeable offices in my power, very truly, Sir,

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[‡] *An addreſs to the members of the different learned ſocieties, ſhewing the deficiencies in profeſſor Euler's memoir on this ſubject, ſee American Muſeum for May 1789.*

Your moſt obedient humble ſervant,

NICHOLAS VAN STAPHORST.

LETTER VIII.

Being an extract of one from J. H. Van Swinden, Profeſſeur de Philoſophie dans l'Univerſité de Franeker, Aſſocié étranger de la Société Royal de Médecine de Paris, Membre des Académies de Bruxelles & de Bavière; des Sociétés de Haarlem & d' Utrecht; Membre Conſultant de la Société de Phyſique expérimentale de Rotterdam, & de la Société de Médicine de la Haye: Correſpondant des Académies Royales de Paris & de Turin.

To determine the longitude by obſervations on declination, is a great undertaking, and worthy of all our encomiums. Navigators are moſt intereſted in its good ſucceſs. This ſucceſs depends, I think, upon the complete ſolution of theſe two very intereſting problems: firſt, to determine by theory what muſt be, at a given time, the declination of the magnetic needle, for every point of the globe, or for every place, whoſe longitude and latitude are given; ſecondly, in a place whoſe latitude is given, the declination at a certain time being known, to conclude its longitude by comparing the ſaid obſervation with the theory.

The firſt problem conſiſts of two parties, the one purely mathematical, the other phyſico-mathematical, becauſe it is a queſtion to draw from the obſervations, the chief data upon which the real calculations are to be founded.

The main part of obſervations made at ſea are deficient, not only becauſe they are perhaps ill made, but becauſe they are ill calculated. I know certainly they commit a conſiderable error with reſpect to this on board of our Eaſt-Indiamen, of our merchantmen, and even on board of ſeveral of our men of war; namely: They take an obſervation of the ſun at its riſing or ſetting, the very moment its centre appears upon the horizon; then they compute its octave, or occaſe amplitude, whence they deduce the declination. But when the ſun's centre ſeems to be in the horizon, he is really 33′ under it: and ſo the arch contained between the needle and the apparent place of the centre, is not the arch contained between the needle and the true centre, and this is more or leſs to the eaſt or weſt, than is ſuppoſed in the calculation. This error, that could be ſo eaſily corrected, may amount ſometimes to two degrees, being one while additional, another ſubtractive. By thoſe means, the declination ſeamen put in their journals is always faulty, though their obſervation be right; I looked over a great quantity of journals, and I ſaw, what was a neceſſary conſequence of what I ſaid, that the declination by amplitude is always different from that by azimuth. And this, though any body might ſay it is of little conſequence in practice, is, nevertheleſs, of great importance in theory, and for the laws that may be deduced from a ſeries of obſervations of that kind.

Report of a Committee of Congreſs, which was publiſhed in the Journal.

In the Houſe of Repreſentatives of the United States, Monday, 20th April, 1789.

MR. Tucker reported, from the Committee to whom was referred the petitions of John Churchman and * David Ramſay,—that the Committee had, according to order, had the ſaid petitions under their conſideration, and agreed to report thereupon; which he delivered in at the Clerk's table, where the ſame was twice read, and debated by clauſes, the firſt clauſe, in the words following,—to wit,

"The Committee have conferred with Mr. Churchman, and find he has made many calculations, which tend to eſtabliſh his poſition, that there are two magnetic points, which give direction to the needle. That, upon this doctrine, he has endeavoured to aſcertain, from a given latitude, and a given variation, what muſt be the longitude of the place; and, having applied his principles to many inſtances in Cooke's Voyages, has found the reſult to correſpond, with conſiderable accuracy, with the real facts, as far as they could be determined by the reckoning of the ſhip. That the object to which Mr. Churchman's labours are directed, is, confeſſedly, of very high importance; and his ideas on the ſubject appear to be ingenious. That, with a view of applying them to practice, he has contrived a map and a globe, whereby to ſhew the angles which are made by the interſection of the real and the magnetic meridians, in different parts of the earth. That he is alſo engaged in conſtructing tables, for determining the longitude at ſea, upon magnetic principles. That the committee are of opinion, that ſuch efforts deſerve encouragement; and that a law ſhould paſs to ſecure to Mr. Churchman, for a term of years, the excluſive pecuniary emolument to be derived from the publication of theſe ſeveral inventions,"—was again read; and, on the queſtion put thereupon, agreed to, by the Houſe.

The ſecond clauſe, in the words following,—to wit: "With reſpect to the voyage propoſed by Mr. Churchman, to Baffin's Bay, the Committee are cautious of recommending, in the preſent deranged ſtate of our finances, a precipitate adoption of a meaſure, which would be attended with conſiderable expence: But they are of opinion, that, at a future day, if Mr. Churchman's principles ſhould be found to ſucceed in practice, it would be proper to give farther encouragement to his ingenuity,"—was again read; and, on a motion made, ordered to lie on the table.

On motion, ordered.—That a bill or bills be brought in, making a general proviſion for ſecuring to authors and inventors the excluſive right to their reſpective writings and diſcoveries; and that Mr Huntington, Mr. Cadwallader, and Mr. Contee, do prepare and bring in the ſame.

Extract from the Journal.

JOHN BECKLEY, CLERK.

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* *Dr. Ramſay's petition was concerning his hiſtory of the revolution.*

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